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FOREST SERVICE

APPALACHIAN FOREST EXPERIMENT STATION

FIFTEENTH ANNUAL REPORT AND PROGRAM

1935 - 1936

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APPALACHIAN FOREST EXPERIMENT STATION

1935 - 1936

Station Headquarters - Federal Building, Asheville, N. C.

Branch Stations and Experimental Forests

Bent Creek - Pisgah National Forest, Asheville, N. C.

Coweeta - Nantahala National Forest, Franklin, N. C.

Fernow - Monongahela National Forest, Parsons, W. Va.

Toccoa - Cherokee National Forest, Blairsville, Ga.

Cooperating Experimental Forests

Berea College Forest - Berea, Kentucky.

Georgia Mountain Experiment Station Forest, Blairsville, Ga.

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Berea College Forest, in cooperation with Berea College, Berea, Ky.

FIFTEENTH ANNUAL REPORT AND PROGRAM

APPALACHIAN FOREST EXPERIMENT STATION

ASHEVILLE, N. C.

NEW DEMANDS ON FOREST RESEARCH

During recent years the role of forestry in land use within the territory of the Appalachian Forest Experiment Station,1/ as in all other forest areas of the United States, has received renewed consideration. This is the result of a number of circumstances including the wider public recognition of the depletion of agricultural land under a type of farming that has led to erosion and wastage of the soil, and the realization that growing of forest crops constitutes an opportunity of economic use and method of restoring the fertility of the soil on the more depleted portions of this land; the surplus production, under existing market conditions, of some of the more important farm crops, and the consequent turning to the production of some other crop such as forest on a portion of the crop land; the greater awakening to the forest growth and industrial potentialities of the region and to the value of forest lands for wildlife and recreational use; emphasis of the part growing and manufacture of forest crops may be made to play in the social and economic stability of the inhabitants of the region; the greater appreciation of the role of forest cover in the regulation of streamflow for industrial and other purposes, the reduction of floods and silting of streams, storage reservoirs and harbors; and the fact that the improvement and development of forest lands offers great opportunity for worthwhile work as a form of emergency relief. Although greater recognition is being given to the place of forestry in land use now than ever before, and active start has been made in realizing on some of the possibilities, the full or even a fair measure of the possibilities are poorly understood. As in most other lines of endeavor extensive research is essential to supply the basic information properly to guide developments.

These new needs have placed new demands upon research organizations which, unfortunately, it has been possible to meet only in part. Nor has it been possible, for example, for research agencies to drop old projects and shift to more pressing new ones. This is so primarily be-

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1/ The Appalachian Forest Experiment Station is one of 12 regional Forest Experiment Stations of the Forest Service, U. S. Department of Agriculture, in the United States. Its territory includes, Virginia, W. Va., N. C., S. C., northern Georgia, and Eastern Tenn. and Ky. The more important Forest areas include the hardwood forests of the Southern Appalachian mountains, the oak-pine forests of the Piedmont and the Southern pine and bottomland hardwoods of the Coastal Plain.

cause the going work was concorned chiefly with problems which are urgent in the new broader application of forestry in the region. Some of the going projects, perhaps, are not as pressing from the standpoint of immediate need as some others which have come to the front in recent years but it would be poor economy to drop work which would involve sacrificing much of the past effort, only to have to revive it again in the future. On the whole, so far as the Appalachian Forest Experiment Station is concerned, meeting these new demands requires additional facilities. This has been supplied in part by the use of emergency funds. Many important problems, however, have been dealt with inadequately or not at all, and emergency funds comprise too indefinite a basis upon which to build a sound research program. What is needed is an enlarged permanent program that will meet the need of the new place of forestry in the region.

Among the more outstanding phases emphasized by the recent developments in forestry in which the work of the Station is deficient are the following:

1. Forest economics including financial aspects of timber growing, marketing and preparation for marketing of farm forest products, and economics of forest land use.

2. A forest survey of the region including inventory of resources, rate of growth, drain and potential development.

3. The influence of forest cover on runoff in relation to regulation of streamflow, flood control and silting.

4. Fire studies including hazard, fire behavior, suppression and detection technique.

5. Expansion in investigation of management of mountain hardwoods.

6. Game studies with particular reference to relation to game of silvicultural practices.

7. Extension of forest nursery and field planting technique investigations.

8. Practices for growing timber in the Coastal Plain (yellow pine type).

9. Methods of managing bottomland hardwoods in the Coastal Plain.

The accomplishments during the past year, plans for the coming year and some of the more urgent problems which cannot be undertaken with present facilities in each of the projects now underway are briefly set forth in the following pages.

MANAGEMENT OF MOUNTAIN HARDWOODS

Accomplishments During the Past Year

A series of 46 volume tables for major species and sites was prepared in cooperation with Region 8. The tables give board foot volumes by diameter and log lengths, and by diameter and average merchantable height.

The study of growth and mortality was expanded, in cooperation with the Tennessee Valley Authority, to include conditions not previously represented. A tract of several hundred acres in the Big Ridge Natural Study Area of the Norris Forest was selected for this purpose and the establishment of permanent plots begun in late winter.

Four hundred seed traps were installed and an equal number of open quadrats established on the Bent Creek and Toccoa Experimental Forests for the purpose of studying the factors influencing seed crops, the periodicity of seed years, the amounts and viability of seed produced by various classes or types of trees, and the effect of biotic factors on seed crops. On each forest, traps and open quadrats were placed under 7 sample trees of each of three contrasting tree classes for white, chestnut, scarlet, black, and northern red oaks. Since these species are an important source of game food, a knowledge of seed production should prove useful for game management as well as for silviculture. On the Bent Creek Experimental Forest, an area of comparatively heavy game population, partial records on open quadrats for the first year showed that the maximum number of acorns were on the ground about the middle of October and that by December 1 almost the entire crop had disappeared. The year was one of poor seed production for the locality, and the exhaustion of an important source of game food early in the winter emphasizes the possibility of critical periods for wildlife which may depend on acorns to a large extent for winter diet.

Marked differences were found in first year height growth of black locust plants grown from seed obtained from 7 domestic and from foreign sources. Seed collected near Parsons, West Virginia, produced the highest proportion of superior seedlings.

Preplanting treatments of black locust seed with sulphuric acid as recommended by Meginnis, gave 71 to 91 percent germination in 7 days. Boiling, the next best method, gave germination ranging from 21 to 30 percent in 22 days.

Establishment of partial cutting plots designed to test the possibilities of selective logging in Appalachian hardwoods, was completed during the summer in Virginia and West Virginia. Data obtained demonstrated that partial cutting in old growth timber could be accomplished without great damage to the thrifty trees held in reserve.

Loss of residual trees attributable to logging damage was about 3 percent of the number originally marked in second-growth saw timber, and ranged from 5 to 15 percent in virgin stands. Losses in advanced reproduction ranged from 20 to 30 percent of the amount present before cutting.

Minor projects begun during the year include studies of the replacement of laurel thickets by interplanting of white pine, following various methods of removing laurel. Seven half-acre plots were established in which removal of laurel was accomplished by clear cutting; clear cutting and grubbing laurel stumps to remove subsequent sprout competition; clear cutting in strips at 12-foot intervals; clear cutting and grubbing in strips; clear cutting in 6- to 8-foot spots at 12-foot intervals; and clear cutting and grubbing in spots.

Several small planting projects were completed. Fifty cuttings each of ten varieties of hybrid poplar (Populus) developed by the Oxford Paper Company of Rumford, Maine, were planted on different sites on the Toccoa Experimental Forest. Very satisfactory survival was obtained and two of the ten hybrids exhibited marked superiority.

A one-acre plantation of 1-0 black locust stock was established on an old field site on the Toccoa Experimental Forest to study the influence of spacing on stem form and growth. Cattle almost completely destroyed the unfenced trees and it is doubtful if plantings of this species is advisable under open range conditions.

Immediate Future Plans for 1936

A new project designed to serve as the basis for better silvicultural practices is planned. First will be made an exploratory study of a single species to develop a method of tree classification by correlating growth history as determined by stem analysis with readily discernible individual tree characteristics. These characteristics will be evaluated for various stages of development next preceding, during and following culmination of volume growth.

Additional work in stand improvement will be concentrated on cove and northern hardwood types of the 10 to 20 year age classes and if time permits will be expanded to include similar age classes in the oak-chestnut types. Different kinds of degrees of crop tree release will be tested.

Expansion of the present series of partial cutting plots to include a greater variety of types is imperative because those established so far are for the most part representative of the heavier degrees of cutting. Additional plots approaching more closely true selection cutting will be established on the Toccoa Experimental Forest in North Georgia, and possibly on the recent addition to the Bent Creek Forest.

Routine work scheduled for the year requires the remeasurement of 127 sample plots, including 11 planting plots, 9 white pine thinning plots in the Biltmore Plantations, 46 stand improvement plots, and 61 growth plots.

Other Urgent Problems

Important problems for which the Experiment Station lacks funds and personnel, include studies of growth and mortality, thinnings in second-growth stands and cultural methods by which the proportion of desirable species may be increased in Appalachian forest types.

The success of sustained yield management with its accompanying social and economic benefits is entirely dependent upon accurate predictions of forest growth rate. Although a number of predicting methods are in use in the Appalachian Region, certain phases of all are based on assumptions for which there is no sound supporting evidence. No reliable method of growth prediction is available for uneven aged stands of mixed species, such as exist in the Appalachian Region. Certain essential information can be obtained only by long time observations on a large number of permanent growth plots. Although the Station has done some independent work and has cooperated with the national forests in one of the two regions in its territory on this project, a number of highly important forest types and conditions cannot be studied with existing facilities.

With the increasing probability that chemical research will undoubtedly develop methods of pulping a wide variety of hardwood species, the importance of proper thinning methods for second-growth hardwoods becomes apparent. As markets develop for pulpwood size hardwoods, the proper thinnings can be made to furnish not only a source of employment and early income, but the means of improving and reducing the time required to produce the final product of high-quality saw timber. The Station has done some work along these lines with both yellow poplar and mixed oak stand, but in recent years inadequate funds have made impossible the continuation of the original thinning program. Considerable expansion of past work is essential. A sufficient number of experiments should be set up so that basic principles for proper thinning methods can be determined before the need for them becomes more acute.

Due to a past history of misuse, the usual forest stands of the Appalachian Mountain Region contain a high proportion of species which are inherently of low technical qualities. In both the dense and more common understocked stands, the introduction of a higher proportion of desirable species is necessary to a realization of the full productive capacity of land devoted primarily to growing timber.

Cultural measures, including various methods of interplanting and direct seeding of desirable species, and seedbed preparation for natural seeding, will doubtless play an important part in the rehabilitation operation. These must be tested before recommendations for widespread use can be made.

Game Studies

Increasing public demand for adequate and well stocked hunting grounds and fishing areas has brought consideration of game management on public lands rapidly to the fore in recent years. Basic information on the life histories and food habits of native game animals and on the influence of silvicultural practices on wild life environment is wholly inadequate for the sound management of game resources. The interrelationships of timber and game management must be studied and fully understood if both these resources are to be developed for the greatest public use. This is a problem for joint undertaking by silviculturists and forest biologists.

In the absence of the assignment of wild life specialists to the project the experiment station will do what it can to gather such information as may contribute to a knowledge of game management.

One important phase is to obtain information on the influence of various silvicultural measures on game food species and to accomplish this, all vegetation on permanent sample plots will be recorded both at establishment and subsequent reexaminations. However, the most the station can do with present facilities will not meet the requirements of the problem.

_____ Leonard I. Barrett

STUDY OF CUT-OVER AREAS IN THE MOUNTAIN REGION

Accomplishments

The purpose of this project is to analyze the data that have been collected in cut-over area and related studies. These data are being compiled and interpreted in order to furnish information upon the composition, growth-rate, and competition of seedlings and sprouts; the growth and crown expansion of the residual trees and their relation to abundance and thrift of reproduction; the composition of the reproduction following the death of chestnut; and other variable factors. An understanding of the natural sequences following cutting, as exhibited on cut-over areas, will aid materially in the improvement of cutting and cultural methods. For example, on plots, at Mons, Virginia, when first mapped, in 1928, chestnut crowns still comprised 25.7 percent of the free crown area. In 1935, all the chestnut having died, the free crown expansion of the residual species amounted to 62 percent, or an increase of 8,272 square feet per acre. Such data are of value in deciding whether residual timber shall be left for continued growth or removed for the benefit of subordinate reproduction.

Plans for 1936

The analysis and interpretation of existing data are to be written up during the year and offered for publication, probably as a technical bulletin. It is proposed to include a discussion of natural replacement of blight-killed chestnut, based upon data obtained from chestnut replacement plots and cut-over area surveys.

Other Urgent Problems

The usefulness of cut-over areas as continuing sources of information and guidance for silvicultural practice strongly recommends the initiation of a field project after the completion of the present analysis. It should (a) parallel and utilize the continuous records kept by the national forest administrations on sale areas, interpreting the silvicultural changes following cutting; (b) utilize records of the Station's permanent plots to the same end; and (c) cover the ecological vegetative succession, and thus help toward a better understanding of the Appalachian forest types from the point of view of successional history. This project could be expected to serve:

1. As a step toward well-based marking rules for different forest types, founded upon a knowledge of the progress of reproduction at different periods after cutting.

2. As an interpretation of the results of harvest cuttings directed toward improvement of composition, on a more extensive scale than would be possible with a necessarily small number of permanent plots.

3. As a means for supplying basic information for cultural work; for example, to determine the best period after logging for the application of cultural work.

4. To arrive at a better understanding of composition of types, based upon the succession after cutting, as well as upon the composition of the mature stand.

5. As a basis for evaluating fire damage, or guiding fire studies relative to changes in composition.

6. As a complement to the seeding efficiency and seed-tree studies.

7. To furnish data for studies of game food.

_____ E. H. Frothingham

MANAGEMENT OF SOUTHERN PINES - COASTAL PLAIN

Accomplishments

Southern pines are the most common as well as the most valuable species in that part of the Station's territory lying east of the Blue Ridge Mountains. Up to the present time practically all of the work in the Coastal Plain portion of the region has been concentrated on loblolly pine.

Analysis of data taken during the course of 1934 field work has been carried forward during the year. A method of constructing yield tables for non-normal stands has been developed and described in a paper to be submitted to the Journal of Agricultural Research, and a table, giving the yield of loblolly pine in stands of various densities and compositions, and growing on different sites, was prepared. A mechanism for determining the densities of loblolly pine stands was presented in Technical Note No. 15. New volume tables for loblolly pine, giving values lower than nearly all preceding ones, prepared from data taken on 36 plots selected for density and age, are believed to be more accurate than previous tables made from data collected in a few stands in which logging was being done.

Results of a study of heartwood in loblolly pine, presented in Technical Note No. 18, will be of value to pulpwood growers and users until researches in newsprint paper manufacture find a method of satisfactorily pulping heartwood. The study indicates that if loblolly pine pulpwood containing less than 5 percent heartwood by volume is desired, open stands growing on good sites should be harvested before they reach an age of 50 years, and dense stands growing on poor sites should be cut for pulpwood before they are 35 years old.

Converting factors for estimating the solid volume of wood in stacks of loblolly pine pulpwood were presented in Technical Note No. 20.

Frequently when peeled pulpwood is to be shipped long distances it is stacked in pens for seasoning before shipment. These pens consist of bolts piled in layers, the two bolts in each layer being laid at right angles to the bolts in the next lower layer. A method of estimating the amount of solid wood in each pen was developed, based on a measurement of the height of the pen and a count of the number of sticks in it. The loss in weight of peeled pulpwood in piled pens was found to be greatest, due to the evaporation of water, during the first 30 days after cutting. Preliminary average weight loss figures for different periods after cutting are summarized on the following page.

Average bolt diam. (inches i.b.)	% green weight lost		
	During 30 days	During 75 days	During 150 days
5.0	26.5	35.3	35.3
6.0	23.0	34.3	35.3
7.0	20.0	31.1	33.0
8.0	18.5	28.8	30.9
9.0	16.6	26.8	29.5
10.0	14.9	25.2	28.3
11.0	13.2	23.6	27.4

The analysis of data collected in the study of the various tree factors affecting seed production of loblolly pine was partly completed. Samples of seeds from 165 completely described loblolly pines were planted in the nursery of the South Carolina State Forestry Commission and subsequently planted in the field near Moncks Corner, S. C. Continuous records on these seedlings should show the value of judicious selection of seed trees in planting and cutting practices.

A cruise was made of the property of the de la Howe Industrial School at McCormick, South Carolina because it supported some of the oldest, unburned stands to be found in the Piedmont region. Some of these stands contain as much as 25,000 board feet per acre. The trustees of the school have agreed to set aside 100 acres of the oldest timber as a natural area to which the Station will have access at all times. Additional data obtained will be of value in the study of the establishment and development of shortleaf pine reproduction and in preparing tentative current annual increment curves for several common Piedmont species.

A plan for establishing growth in plots in the Coastal pine forests was prepared. Station personnel cooperated with the staff of the Sumter National Forest in establishing over 200 plots following this plan.

Proposed Plans

The analysis of existing data will be completed and results prepared for publication in technical notes and other papers. Much of the information now available will be coordinated in a bulletin on the growth and production of loblolly pine pulpwood.

An experimental forest will be established on the Wambaw Division of the Sumter National Forest. If time permits permanent growth strips will be established on this area.

Other Urgent Problems

Methods of cutting studies are essential to the development of sound management policies for all southern pine forests. Likewise, a large-scale study of the methods of thinning and stand treatment that should be practiced to develop crops of desired products must be carried on before it will be possible to evaluate the economic possibilities of growing southern pines.

Before sound and region-wide methods of establishing desirable reproduction can be recommended, studies of seed production and of soil and weather factors affecting reproduction establishment must be made.

A study dealing with methods of converting many stands now composed of undesirable species, or trees of poor quality or form, into stands of desirable species of good form will also be necessary for the development of forest management practices in the region.

_____ A. L. MacKinney

MANAGEMENT OF PIEDMONT OAK-PINE FORESTS

Work will be started in the oak-pine types of the Piedmont Region during the coming year. Since practically no forest research has ever been done in this Region, the first task will be a survey of the major forest problems and their relative importance. This will involve a general reconnaissance of the region, determination of the relative areas of different forest types and conditions, and conferences with local foresters, state foresters, agricultural experiment station personnel, and lumbermen. The following preliminary outline of the problems in order of their immediate importance is offered:

Silvicultural Studies Needing Attention in the Piedmont Region in their Approximate Order of Priority.

I. Methods of putting submarginal agricultural land into forest production.

   1. Natural

   2. Artificial

      a. Planting

      b. Seed spots

      c. Soil treatment

II. Finding criteria for classifying lands for forest production purposes by:

   1. Developing mechanics for estimating growth and yield of the several important species growing under different conditions.

   2. Developing methods of evaluating potential productive capacity of different sites without timber stands.

III. Methods of managing present and future timbered lands by determining:

   1. How to increase stocking of young understocked stands by:

      a. Cultural measures for reproduction establishment.

      b. Planting

   2. Methods of increasing the proportion of desirable, well-formed trees by:

a. Cleanings

b. Improvement cuttings

c. Release cuttings

d. Reproduction establishment methods

e. Pruning

3. Measures to be applied to good, immature stands to obtain maximum volume and quality production, including:

a. Thinnings

b. Cleanings

c. Pruning

4. Best silvicultural practices for harvesting timber by:

a. Methods of cutting

b. Additional steps to favor reproduction of desirable species and form.

During the period of orientation it will be best to undertake investigations that require a relatively short time for completion. The following studies are being considered:

1. A study of existing plantations and of the rate of natural reforestation on depleted and abandoned old fields.

Such a study should give at least a broad basis for selecting lands needing planting and should allow the determination of possible results to be expected from plantations on different types of land as compared to natural reforestation. A study such as this would also assist in the development of specific work under heading I.

2. An extensive study of the growth rates of the most abundant species.

Results should provide a basis for rating the relative desirability of species to be favored in timber management, the approximate classification of tree characteristics indicative of good growth rate, and might lead to a site classification for the most abundant hardwood species.

3. An exploratory study aiming at a method of classifying Piedmont lands for forest production purposes. If, after a limited

amount of work, it is found that growth rate and species associations are significantly correlated with soil type, soil conditions, and drainage, this project might be expanded to obtain data applicable to the entire Piedmont Region. Concurrent with this expanded project, data could be collected for the construction of non-normal yield tables for shortleaf and Virginia pines.

_____ A. L. MacKinney

FIRE INVESTIGATIONS - MOUNTAINS

Accomplishments During the Past Year

Fire Damage

The last of a series of large plots, to be experimentally burned, was established on the Fernow Experimental Forest in West Virginia. There are now under observation, two major series of plots at Bent Creek of 14 1/2 and 5 1/2 acres respectively, a third on the Toccoa Experimental Forest in North Georgia of 11 acres, and a fourth on the Fernow of 18 1/2 acres.

The only method developed so far for judging the fire intensity to which a burned area in the Appalachian hardwood region has been subjected is by the use of curves based on the percent of mortality in 3-inch or other diameter classes. The curves when checked against mortality from experimentally burned plots, appear to be satisfactory. It has been found that the length of time between the occurrence of the fire and tally of mortality materially changes the fire severity class. For instance, on a Georgia plot, tallies made in June within a few months after the fire indicated a severity class of 1, whereas a tally in October indicated Class 2. Similarly at Bent Creek, a tally at one year after the fire indicated Class 2, but four years after, Class 4. Thus, wide differences can be expected if a standard time of examination after a fire is not used. The aim now is to determine the relationship between immediate and ultimate mortality so that the latter can be predicted from the former. The plan is eventually to relate other forms of damage such as growth rate, degree of wounding, and subsequent decay to these fire severity classes.

Instructions for the establishment of semi-permanent line plots under the cooperative agreement with the Supervisors in the Station's territory were issued last fall. So far seven pairs have been established, six on the Nantahala National Forest, and one on the Cherokee National Forest, for the purpose of determining the extent of mortality over a period of years.

Methods of cutting plots established in 1929 on the Mountain Lake Unit were accidentally burned in the very severe McFalls Creek fire in the spring of 1930. An examination of the reproduction quadrats in 1935 indicates that although the fire had practically eliminated white pine, it did not prevent the development of a good stand of hardwood reproduction. Lacking unburned check plots on the Mountain Lake, a comparison was made with unburned plots which had been selected as excellent examples of mixed hardwood reproduction on the Pisgah National Forest. The following table permits a rough comparison of the two areas.

	Burned Area Mountain Lake	Unburned Area Pisgah N. F.
Number free single stems per acre	3640	1500
Number free single stems of desirable species per acre	2260 (62%)	969 (65%)
Percent of desirable single stems free	38	8
Number free sprouts per acre	6960	900

The extent of deer browsing of hardwood sprouts originating from the bases of fire wounded trees was determined on one of the large experimentally burned plots located near the Pisgah Game Preserve. The following table gives by species the number of sprout clumps and percent of clumps browsed.

Species	No. sprout clumps	Percent clumps browsed
Desirable timber species		
White Oak	362	57
Black Oak	66	68
Scarlet Oak	95	51
Chestnut Oak	79	68
Hickory	65	59
Black Locust	82	43
Less desirable timber species		
Black Gum	141	96
Sourwood	313	89
Red Maple	76	93
Dogwood	573	36

Since only the number of clumps and not the total number of sprouts which were browsed is known, the above figures may be but partially indicative of species preferred by deer.

Detection

Knowledge of visibility range is indispensable to efficient spacing of lookout towers and is of value in determining when secondary lookouts or patrolmen are necessary. Series of test smokes at distances ranging from 5 to 12 miles indicated that the Byram Haze Meter developed at the Pacific Northwest Forest Experiment Station is satisfactory for the Appalachian Mountain Region. At least three National Forests in

Region 8 and one in Region 7 are planning to cooperate with the station in visibility studies during the coming year.

Trials made with the Osborne photo-recording transit and infra-red film were so satisfactory that the Pisgah, Cherokee, and Nantahala National Forests are making panoramic photographs from all lookout towers. A junior forester from the Pisgah, trained in the use of the camera by the Station, will also work on several forests in Region 7.

Instructions for the eyesight test for lookouts developed by the Pacific Northwest Experiment Station, were prepared and circulated to Forest Supervisors in both regions. On the basis that the tests were given according to instructions and according to the standards developed by the Pacific Northwest Station, approximately 1/3 of the lookouts tested in Region 8 had eyesight ratings less than good and should therefore not be used as primary lookouts.

Proposed Plans

At the investigative meeting with Regions 7 and 8 in March, it was suggested that the station shift the major emphasis of fire investigations from damage studies to detection, fire hazard, and fire behavior studies. While damage investigations will not be neglected, a point has been reached in the project work which will permit a partial realignment of priorities. Accordingly, it is planned that a member of the Station's staff visit other experimental forests, particularly those in the West, during the coming summer for the purpose of observing first hand, the technique used in solving fire problems there and subsequently to adopt the technique, in so far as possible, to Appalachian region conditions.

In addition to routine plot examination, work is planned on the following phases:

Damage

(1) Effect of fire on growth. A thorough growth analysis will be made of a limited number of fire wounded trees, the purpose being to determine whether or not a more extensive study is justified. If growth reduction appears not to be highly significant, data from experimentally burned plots will be sufficient for the purpose.

(2) Decay entering through wounds being one of the principal losses resulting from fire, it is hoped that a cooperative study with the Division of Pathology can be undertaken. The purpose of the study would be to develop methods for predicting by species, diameter, and degree of wounding, the amount of cull which can be expected at a future time.

Detection

(1) Since a knowledge of visibility range is prerequisite to detection planning, a cooperative study with at least four national forests in the Station's territory will be started.

(2) A detection planning study on one or two selected ranger districts will be made. The purpose is to check the efficiency of the existing systems, and to determine how and where changes, if needed, may be made in order that the most effective system be obtained at an acceptable cost. Some analyses of past fire reports will also be made more clearly to define fire protection problems needing attention.

Weather and Behavior

(1) Work on methods for making a quick and reasonably accurate determination of the moisture content of hardwood leaf litter will be continued.

(2) Working plans for a cooperative study with National Forests on rate of fire spread will be prepared. It is hoped that investigations on a fairly extensive scale will be started during the fall fire season.

Inasmuch as the foregoing phases are semi-administrative in character - involving the adoption and application of western technique to local conditions, in which, however, some special research will be necessary - and will over-tax the facilities of the Station, extensive contributions and cooperation of the Regions will be needed to accomplish the program outlined.

Other Urgent Problems

Failure to recognize conditions of extreme hazard sufficiently early is a weakness of protective organizations. Although not of common occurrence, when extreme conditions do occur loss is likely to be great. Even if weather conditions could be predicted exactly, standards by which to judge the degree of hazard are not available. A study of fuel types, combustibility of fuels under different conditions of moisture, correlation of weather with fuel moisture in order that a direct prediction of hazard can be made, and a study of fire behavior is needed. The purpose of the investigation would be to evolve a predicting mechanism whereby degree of predicted hazard can be translated directly into planned action by the protective organization.

_____ Ralph M Nelson and C. A. Abell

FIRE INVESTIGATIONS - COASTAL PLAIN

Accomplishments

No work was done on this project during the past year.

Proposed Plans

The only work proposed for the coming year in this study is the reexamination of a large group of controlled burning plots at Lanes, S. C. No further work is planned on this very important project until funds are made available.

Other Urgent Problems

(a) To develop methods of estimating and predicting fuel hazard and of predicting action of going fires in order to better equip the forest manager for handling his suppression organization.

(b) To determine the influence of fire on establishment, development, and growth of forest stands, with particular emphasis on prediction of mortality and reduction in growth rate.

(c) To determine radius of vision under different atmospheric conditions for fires of different sizes burning under different conditions.

(d) To codify existing presuppression and suppression methods and to try improved methods with the primary aim of improving present tools and equipment and developing new tools and equipment.

_____ A. L. MacKinney

FOREST INFLUENCES

Accomplishments During the Past Year

1. Influence of Forests on Streamflow.

Records of the continuous flow of streams from twenty-three small watersheds, representing different types of forest and other vegetative cover conditions for periods of from one to two and one-half years were compiled. They show that for the twelve months period, July 1, 1934, to June 30, 1935, the average maximum flood flow for all the forested water-sheds amounted to only 38 cubic feet per second per square mile; for grassed and abandoned agricultural land, 432 c.f.s. per square mile; and for completely denuded land, 1304 c.f.s. per square mile. In no case did the storm runoff from forested watersheds assume critical flood conditions, whereas from the non-forested watersheds, numerous instances were recorded in which the maximum flow assumed very serious flood proportions. Although there were a number of storms of high precipitation, no exceptionally high floods occurred in any of the major streams of the region.

2. Erosion.

The tremendous differences in soil removed under different conditions of cover is well illustrated by the storm of February 13 and 14, 1935, in the Copper Basin area of Tennessee. This storm had a total rainfall of 2.50 inches with a maximum intensity of 0.15 inches in twenty minutes. Although not particularly intensive, it may be regarded as a rather heavy storm due to its duration of fourteen hours. During this storm, an average of 8.3 tons of soil per acre was removed from a small denuded watershed of 15.6 acres. The amount of soil that has been removed per acre from forested watersheds throughout 2 1/2 years of measurement has been insignificant.

3. Influence of Forests on Local Meteorological Conditions.

Continuous meteorological records taken within the three vegetative zones of the Copper Basin of Tennessee, as shown in the following table, indicate that forest cover exerts a very favorable influence in modifying extremes of air and soil temperature, and reducing high wind velocities and excessive water evaporation. The observation stations are situated in (1) the normal forest of the locality, (2) the zone where smelter fumes were sufficiently concentrated to destroy forest cover but a grass cover is present, and (3) the zone nearest the smelter where fumes have destroyed the forest and all other cover.

Of outstanding interest is the markedly higher precipitation, lower wind velocity, and lower evaporation in the forested zone. The extent to which the differences, especially in precipitation, may be due to factors other than plant cover, will be determined by further observation.

COPPER BASIN OF TENNESSEE

Records for Fourteen Months Period

December 1, 1934 - January 31, 1936.

	FORESTED ZONE	GRASSED ZONE	DENUDED ZONE
PRECIPITATION	Total Precipitation	Total Precipitation	Total Precipitation
Dec. 1934 - April, 1935	24.53	21.53	20.34
May - October, 1935	16.60	13.77	10.21
Nov. - January, 1936	21.24	20.50	18.84
Total	62.37	55.80	49.39
WIND	Average Miles Per Hour	Average Miles Per Hour	Average Miles Per Hour
Dec. 1934 - April,1935	0.9	5.1	7.0
May - October, 1935	0.2	3.9	5.1
Nov. - January, 1936	0.9	4.7	5.4
MAXIMUM AIR TEMPERATURE	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit
Dec. 1934 - April,1935	55.3	55.8	54.9
May - October, 1935	77.8	81.5	81.3
Nov. - January, 1936	47.7	47.2	45.6
MINIMUM AIR TEMPERATURE	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit
Dec. 1934 - April,1935	34.0	38.1	37.7
May - October, 1935	53.9	56.8	58.2
Nov. - January 1936	28.0	31.2	31.1
SOIL TEMPERATURE AT 0" DEPTH	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit
Dec. 1934 - April,1935	46.8	47.1	45.3
May - October, 1935	66.2	74.2	73.3
Nov. - January, 1936	40.7	41.1	40.9
SOIL TEMPERATURE AT 6" DEPTH	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit
Dec. 1934 - April,1935	47.4	47.3	46.1
May - October, 1935	63.4	69.8	71.5
Nov. - January, 1936	43.6	43.3	42.7
EVAPORATION IN INCHES	Inches	Inches	Inches
Dec. 1934 - April,1935	2.700	5.840	6.600
May - October, 1935	6.466	26.573	40.378
Nov. - January, 1936	2.248	4.138	5.189
Total Inches	11.414	36.551	52.067

4. Road Bank Protection Studies.

Planting tests indicate that on banks and fills where actual soil is present, planting can be carried out with good results. The soft and decomposed rock that is frequently exposed in road construction within the region, and sometimes mistaken for soil, can be covered with vegetation only by considerable effort. The following summary indicates some of the results.

Slopes as steep as 1-1 or possibly 3/4-1, having a rounded upper shoulder, may be considered satisfactory for planting, other things being favorable.

Sod transplants of honeysuckle set in deep furrows or pockets have proved most successful. Ground myrtle will grow on moist slopes, but at a relatively slow rate. Kudzu grows vigorously on rich slopes, but dies down in the winter and is generally less desirable than honeysuckle. Root clumps of sod forming grasses have been fairly successful when set in deep furrows on the back slope. Cuttings of poplar and willow may be expected to root well when planted on the lower slopes of moist fills.

Seeding of grasses, small grain and legumes may be expected to be successful on loose fills treated with a complete fertilizer, if carefully raked in.

5. Direct Seeding Studies.

During the past year, 176 one-tenth acre plots were established, to test different methods of direct seeding of forest trees. The planting was done in late April, using seed that was stratified in sand and placed in cold storage for six to eight weeks, or treated with sulphuric acid, before planting. The following table gives a brief tabulation of establishment results at the end of the 60-day germination period. Percent figures indicate the extremes by individual plots, expressed as the proportion of spots planted having one or more vigorous seedlings.

Cover Type: Oldfield-Broomsedge

	Shortleaf Pine	Loblolly Pine	White Pine	Black Locust
Broadcast Seeding	2 - 9%	0 - 4%	--	2 - 3%
Spot Seeding				
Seed not covered	2 - 57%	0	0 - 2%	--
Seed covered	21 - 86%	54 - 80%	7 - 61%	35 - 94%

Cover Type: Burned-over Forest

	Shortleaf Pine	Loblolly Pine	White Pine	Black Locust
Spot Seeding				
Seed covered	--	--	55 - 73%	--

Cover Type: Denuded and Eroded Land

	Shortleaf Pine	Loblolly Pine	White Pine	Black Locust
Broadcast Seeding	0	0	--	0
Spot Seeding				
Seed Covered	0 - 3%	--	--	0 - 64%

6. Influence of Vegetative Cover on Water Absorption by the Soil.

Studies have been carried out along three related lines, including: (1) Physical changes in the different horizons of the soil profile as influenced by vegetative cover; (2) Biological activity within the organic horizons of the soil profile; and (3) Restoration of favorable absorption by means of desirable plant succession on depleted land areas.

The analysis of a great many soil profiles has led to the following deductions:

In forests the soil receives a new supply of organic matter each year. This acts, by swelling and shrinking, to produce particle movement, and to develop lines of weakness along which the soil shears when subjected to climatic stress. Also, by surrounding individual soil particles with an insulating film of organic matter, granular structure may be developed. In addition, a new supply of soluble organic matter maintains from year to year fungous and bacterial growth along the cracks in the soil, thus increasing the intensity of the lines of cleavage. These factors, in themselves, tend to keep forest soil well aerated and porous, favoring the absorption of meteoric

water. Insects, worms, and rodents also aid in the creation of porosity of soils, and their activity is favored by conditions found on the normal forest floor. The decomposition of deeply penetrated tree roots creates additional porous channels not found except under forest cover.

Obviously, frequent burning of forest lands tends greatly to destroy the normal functioning of the organic matter and micro-organisms in the soil.

Continuous culture of clean cultivated crops has frequently led to exhaustion of soil nutrients and complete destruction of favorable soil structure for water absorption throughout the mountain and Piedmont agricultural areas. When this depleted land is abandoned for agriculture, it constitutes decidedly unfavorable conditions for absorption of rainfall. For the most part, some type of natural weed cover will establish itself except where soil movement is severe due to winter stress and erosion. Trees may also enter old fields soon after abandonment if seed trees are available. The study of soil profiles in different kinds of abandoned land indicates that the greatest problem to be met occurs the first few years after abandonment. During this period the soil is no longer being plowed or cultivated and insufficient vegetative cover is present to retard runoff. The forester must consider that rehabilitation of old fields begins at the time of abandonment, and that it is within his province to hold the soil by terracing, plowing, or other cultural methods, including the use of fertilizers on natural weed cover and by special cropping of annuals, if necessary, to protect against further depletion of the soil during the period between abandonment and tree plantation establishment.

Soil profile observations further indicate that a tree cover once established on abandoned fields is the most favorable type of vegetation to promote water absorption. This is due chiefly to the deeper penetration of tree roots, the large quantity of organic matter added to the soil each year, and the more favorable opportunities created for biological activity in the soil.

Plans

1. Measure of Vegetation Control.

Continuous records will be obtained from thirty streams arising on small watersheds located on experimental areas. These records are being summarized on a weekly basis, and the results of analysis will be made available during the coming year.

2. Measure of Forest Influence Upon Meteorological Conditions.

Continuous records from nine additional meteorological stations will serve as a basis for comparing forest cover with other vegetative cover in relation to meteorological conditions.

3. Development of Major Forest Influence Experimental Areas.

The Coweeta Experimental Forest is now being developed to furnish a record of the complete water cycle under forest management in a region of relatively high rainfall, mountainous topography and Archian granite formation. All of the major streams are to be gauged, a complete series of meteorological stations is being installed, and sixteen ground wells have been established to observe sub-surface water movements. Necessary communication trails and roads are being developed through C.C.C. and E.R.A. labor.

Meteorological, runoff, and erosion data, under present forest conditions, will be obtained for each sub-drainage for a period sufficient to establish a sound basis for future comparisons. Then the cover on various watershed units will be modified in different degrees and records will be continued for a long enough period to determine the influence of the modification on flood flow, total discharge, erosion, and other elements of streamflow as compared to present cover conditions.

4. Improving Watershed Conditions

Roadbank protection studies will be restricted to observations of banks of different degrees of slope and to further records on planting tests already under way.

Direct seeding studies will be carried out chiefly within the denuded zone of the Copper Basin, using treated black locust. A small amount of seed of other species will be seeded late in the spring or early summer as a check upon the 1935 results.

5. Supplementary Studies of Water Absorption as Influenced by Biological Activity.

Supplementary studies of water absorption will be restricted during the coming year, due to insufficient funds. Two pertinent problems are being investigated. One is the insect ecology of leaf litter disintegration and disappearance, with special reference to the formation of the H-layer of the soil profile. The other is the insect ecology of dead tree root channeling.

6. Supplementary Studies of the Water Cycle.

Aerial interception by tree canopies has been studied for the

past two years. Observations will be continued throughout the growing season of 1936 to furnish sufficient data for computation and analysis.

Urgent Needs for Further Studies

1. Measure of Vegetation Influence in Areas not yet Represented by Present Studies.

An urgent need exists for additional records of watershed behavior in sections of the region not now represented by the Station's installations. These should include the sedimentary formations of the Cumberlands, and the Piedmont.

2. Water Absorption as Influenced by Forest Type and Condition Class.

Supplementary studies are also needed that will measure the comparative rate of water absorption under a large number of different forest types and condition classes throughout the region. These can be carried out by means of field lysimeters, using artificial and natural precipitation.

3. Watershed Improvement.

Additional studies are needed of methods of watershed improvement by means of roadbank protection, gully control, and the protection of bare and depleted soils that would ordinarily not be considered as favorable tree planting sites. It is probable, however, that the successful planting of many depleted oldfields on the Piedmont will come under the head of land salvage, rather than establishment of a commercial plantation. The establishment of plantations under unfavorable soil conditions may be still an experimental procedure in watershed improvement. If such is the case, further studies are required, using the most severe soil conditions available as the testing ground.

Information on the influence of forest cover and its treatment on streamflow and erosion represents one of the biggest gaps in existing knowledge of forest land problems. By and large, the chief water producing areas of the United States are forest or potential forest land. In the Appalachian region the major portion of the streamflow used for navigation and hydroelectric power originates in the mountain watersheds as may also much of the destructive flood waters. It has long been recognized that forest cover exerts a profound influence on regularity of streamflow, on the control of flood waters and the siltload of streams. Yet knowledge of the true relationships upon which to base management technique or other lines of action to accomplish desired ends in streamflow control, is sorely lacking. This foremost of problems merits far wider public attention than it has received heretofore.

C. R. Hursh

FOREST PATHOLOGY

Bureau of Plant Industry, Division of Forest Pathology,
In Cooperation with Appalachian Forest Experiment Station.

Since the inception of the ECW, research has been carried on in forest tree diseases in the Appalachian Region primarily to improve those stand improvement practices of the CCC involving the handling of disease problems. This work has been done on Emergency Conservation Funds. Some other work not relating specifically to the CCC program has also been carried on, with regular funds. During the fiscal year 1935-36 George H. Hepting has been responsible for the tree disease research in the Appalachians and E. R. Roth, ECW Junior Forest Pathologist, has been conducting the stump sprout decay investigations in this region. The carrying out of proposed work is dependent upon the availability of funds.

Accomplishments

The sampling work in connection with the investigation of decay factors in sprout hardwoods in northern Virginia has been completed. Nineteen one-fifth acre plots in young sprout oak have been cut clean and the amount and origin of decay studied. Of the 1584 trees dissected 23% were butt-rotted and the average height of decay in the butt-rotted trees was 42 inches. Practically all of the decay had been transmitted from the parent stumps. The work so far has indicated that a definite decay hazard exists in sprout oak timber resulting from repeated cutting on short rotation, and that measures taken to favor seedlings, sprouts from small stumps, and sprouts arising close to or below ground level will reduce the incidence of decay.

Long-time plots have been laid out to study the effects of removing one of a pair of twins on decay and growth rate of the remaining stem, to determine whether the height of origin of sprouts on stumps can be regulated by cutting at any particular time of year or by regulating the amount of canopy left over the stump, and to determine whether cross-ties will decay faster if they contain active mycelium when put in use.

Two hemlock diseases of local importance have been studied. One, a twig blight caused by the rust fungus Melampsora farlowii, has been causing heavy losses in commercial nurseries and some losses in the forest; the other, a smothering disease of hemlock foliage and twigs caused by a newly discovered species of Rosellinia, has caused heavy defoliation in several coves of the Pisgah Division of the Pisgah National Forest. Spraying experiments to control the rust are being started this year.

A vascular wilt of the mimosa tree was discovered this year at Tryon, N. C., and near Bishopville, S. C. Several dozen trees, large and small, have been killed at both places. The disease seems to be caused by a species of Fusarium, and, in all probability, spreads through the soil. Trees have been found completely defoliated as early as one month after the first wilting of leaves became apparent. Cross-inoculations to test the pathogenicity of the Fusarium isolated to mimosa and other plants have been started.

The work-up of the Appalachian hardwood decay data taken by Dr. Hedgcock from 1924-28 has been completed. Some of the results have been released in the Technical Notes listed below, and a manuscript covering all of the results of this work has been prepared.

Proposed Work

The investigation of decay in stump sprouts is to be carried to other parts of the region in cooperation with the National Forests. Further measures to cause sprouts to arise low on stumps will be tried. The data obtained so far on this entire project is to be completely analyzed and written up, possibly for publication.

A study of the amount of decay following fire-wounding will be made, as a part of the Station's fire damage appraisal investigation.

Further cross-inoculation work with strains of Nectria from different hosts will be made with the view to determining the crossing of the different strains from one tree species to others.

Further work on the cause and prevention of the wilt of mimosa will be carried on.

Control measures for the twig rust of hemlock will be attempted.

Plans for nursery and plantation disease work are formulated and carried out by the Washington office.

Other Urgent Problems

The amount, cause, estimation and reduction of decay in conifers, particularly the southern pines in the Piedmont and Coastal Plain regions.

If blue stain is definitely found to be a problem in the production of paper from southern pines further work should be done on the amount of stain that develops in peeled and unpeeled wood, hand and machine-barked wood, and wood stored under different conditions and at different times of the year.

The effect of different logging practices on the entrance of decay in the remaining trees through wounding.

The extent to which heart rot fungi fruit on felled and girdled timber. This is related to the practices of eliminating conky trees in stand improvement operations.

Pathogenicity and control studies on the Strumella canker of oaks.

_____ G. H. Hepting.

PATHOLOGY

CENTERS OF WORK OTHER THAN EXPERIMENTAL FORESTS

Stump-sprout decay plots

Edinburg, Buena Vista, Sherandro, and Jerome, Va. Breakneck, W. Va.

Hemlock twig rust

Pineola, N. C.

Mimosa wilt

Tryon, N. C.

FOREST ENTOMOLOGY

Bureau of Entomology and Plant Quarantine
In Cooperation with Appalachian Forest Experiment Station

Accomplishments

1. White grub investigations.

The continuation of white grub investigations has given some good leads from which to work. A number of the findings have been positive, but all cannot be called conclusive until further tests are made.

The biological studies have indicated:

a. How seedbeds became directly infested with white grubs.

b. Which stages of the white grubs can and do cause serious losses in pine seedbeds.

The control investigations gave evidence that:

a. Some chemicals, whether or not effective against grubs, are injurious to pine seedlings.

b. Chemical as well as mechanical barriers may be used effectively to prevent oviposition in seedbeds.

c. Grubs may be satisfactorily controlled in pine seedbeds.

In addition, the studies have shown that:

a. Larvae of Polyphaga can kill pine seedlings.

b. Larvae of Elasmopalpus can and do kill black locust seedlings in nurseries.

Although considerable knowledge contributing to the solution of the other going projects has been added, complete analyses of the data have not been made to date and necessarily complete results cannot be given at this time regarding them.

2. Tree medication as regards brood control and wood preservation.

3. Interrelationships of bark beetles and the blue stain fungi, yeasts, and other fungi.

4. Seasonal moisture variation in pines.

5. Plant succession in beetle-killed pine stands.

6. Correlation of pine stand improvement work and beetle kills.

The southern pine beetles have been relatively scarce during the past year. Those few small outbreaks and kills found have not been caused as a result of stand improvement work or road construction. The few Ips kills examined, while possibly attributable to pine cuttings in E.C.W., are of little consequence. To date, there has been found no conclusive evidence that cutting of pine, as done in E.C.W., either encourages or hinders bark beetle outbreaks.

Proposed Plans

1. As during the past year, the white grub studies will be concentrated at the Georgetown, S. C., Nursery. There will be a continuation of those going tests and an additional number of new tests.

2. Attempts will be made, as planned last year, to control broods of the southern pine beetle by spraying or injecting the attacked trees with chemicals.

When the data from the past year's tests of copper sulphate distribution in shortleaf pines are assembled, definite plans for the new work will be formulated. Until then, however, the tentative plans are to try on larger trees and possibly on trees of other pine species those dosages of copper sulphate that have given best distribution. Tests will also be made using other chemicals and with hardwoods.

3. Studies will be undertaken of the interrelationships of bark beetles and the blue stain fungi, yeasts, and other fungi.

4. The seasonal moisture studies in pines will be continued. Attempts will be made to correlate chemical poison distribution in trees with the moisture content of the trees at different seasons.

5. In continuation of the study of plant succession in pine stands killed by the southern pine beetle, the vegetation and growth on these areas will be investigated.

6. Follow-up studies of cut pine stands will be made to add to the data correlating bark beetle damage with factors such as time and methods of cutting.

Other Urgent Problems

In the following list are problems needing attention and problems that must be answered. However, the going projects need be given priority both because of their importance and in order to best use the contributory information thus far attained leading to their solution.

1. Pine tip moth studies in pine plantations.

2. White grub studies in plantations and proposed planting sites.

3. Investigations of insects as concerns pine pulpwood.

FIRE-WEATHER WORK

Weather Bureau in Cooperation with Forest Service

The fire-weather program of the Weather Bureau for the Southern Appalachians was interrupted somewhat by the transfer of Mr. L. T. Pierce last summer. Partly because of a desire to become better acquainted with this work in this section, his successor delayed the extension of the service northward into Virginia and West Virginia until after the fall season. The severe winter has spoiled whatever opportunity there might have been to establish additional weather stations before the spring season. These delays are regretted, of course, but the long-contemplated extension of the service will most certainly be made this year.

In the meantime, if not already being done, it is suggested that psychrometers be supplied all lookout stations and that dry and wet readings be made at least at 1 p.m. and 6 p.m. These readings, or the relative humidities, could be phoned immediately to appropriate officials, especially when the relative humidity drops to 30 percent or lower, indicating high fire hazard, almost without regard to other factors. Such a scheme has the added advantage of perhaps increasing the interest of the lookout and lessening skepticism.

The above is not only suggested as a stop-gap where fire-weather service has not been extended, but also as a supplementary measure or program for the entire region. Weather Bureau sub-stations are necessarily rather widely scattered and attempts to localize forecasts are plainly limited. Nor are they infallible.

The network of 18 weather stations has been maintained, with 12 of these reporting daily during fire seasons. At least two stations each are planned for the Monogahela, George Washington, and Mountain Lake National Forests. Service will be extended to the Piedmont and Coastal Plain Regions as funds permit.

The Fire-Weather Official will cooperate in hazard and behavior studied, other duties permitting.

_____ H. A. Downs.

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No. 17. — Plant indicators of soil conditions on recently abandoned fields. - By C. R. Hursh and W. M. Crafton.

No. 18. — Heartwood in second growth loblolly pine. - By A. L. MacKinney and L. E. Chaiken.

No. 19. — Recent volume tables for some southern Appalachian species. - By L. I. Barrett.